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ABSTRACT

Sixty-one grade 1 students experiencing early reading difficulties received either a cognitive remediation program (PREP; PASS Remediation Program) designed to facilitate successive and simultaneous processing skills, or a meaning-based language enrichment program designed to provide children with meaningful experiences in reading. Repeated measures analysis of variance showed that both groups improved their word recognition and decoding skills. Moreover, "time by group" interaction was significant for the word decoding task, indicating that the PREP group gained significantly more than the meaning-based group. Cluster analysis with planning, attention, simultaneous processing, successive processing, and phonological coding tasks as independent variables indicated that three distinct subgroups of children with early reading difficulties could be identified. The first group performed below the control group level on all tasks. The second group performed at or near control group level on most cognitive tasks and on both phonological coding tasks. The third group performed significantly poorer than the comparison group an all successive processing and phonological coding tasks, but not on planning, attention, or simultaneous processing tasks. Cognitive profile remediation interaction indicated that children who benefited most from remediation had higher preintervention scores on several cognitive tasks than children who did not benefit from remediation. (Contains two tables and one figure of data.) (Author/RS)

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Cognitive Profiles and Early Reading Remediation of At-Risk Elementary School Students

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ABSTRACT

Sixty-one Grade 1 students experiencing early reading difficulties received either a cognitive remediation program (PREP; PASS Remediation Program) designed to facilitate successive and simultaneous processing skills, or a meaning-based language enrichment program designed to provide children with meaningful experiences in reading. Repeated measures ANOVA showed that both groups improved their word recognition and decoding skills. Moreover, Time X Group interaction was significant for the word decoding task, indicating that the PREP group gained significantly more than the meaning-based group. Cluster analysis with planning, attention, simultaneous processing, successive processing, and phonological coding tasks as independent variables indicated that three distinct subgroups of children with early reading difficulties could be identified. The first group performed below the control group level on all tasks. The second group performed at or near control group level on most cognitive tasks and on both phonological coding tasks. The third group performed significantly poorer than the comparison group on all successive processing and phonological coding tasks, but not on planning, attention, or simultaneous processing tasks. Cognitive profile remediation interaction indicated that children who benefited most from remediation had higher preintervention scores on several cognitive tasks than children who did not benefit from remediation.

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1. INTRODUCTION

This study addressed two questions: (1) How effective is a cognitive training program in remediating early reading difficulties, and (2) Are children displaying early reading difficulties a homogeneous group in terms of their cognitive and phonological processing skills?

Early approaches to remediating reading often focussed on improving memory functioning through strategy training of one kind or another. A number of studies employing this approach demonstrated that while reading disabled children did improve their performances after learning specific strategies, the transfer of the strategies to new, even very similar, tasks was poor.

More recent approaches to reading remediation have generally focussed on the teaching of phonological coding or grapheme-phoneme rules. While this approach has met with some success, we believe that it still has not been able to address the roots of the problem at the cognitive processing level of analysis.

We believe that reading disabled children require a method of intervention that addresses those cognitive processing deficits that are fundamental to reading and may well constitute the main source for reading difficulties. Several earlier studies by Das and his colleagues have shown that poor readers are also poor in successive processing, that is, encoding information that is presented in a temporal sequence. Also, initial analyses of longitudinal indicate that successive processing skills are causally related to phonological coding skills and further, to early reading acquisition.

Following this line of research, the first goal of this study was to evaluate the effectiveness of a cognitive training program called PREP (PASS Remediation Program) in remediating early reading difficulties. PREP aims at training participants' successive and simultaneous processes. Thus, it goes beyond phonological deficits that are frequently associated with reading problems but which may in fact be subsequent to successive processing problems.

The second goal of this study was to examine whether children displaying difficulties in their early reading acquisition are a homogeneous group in terms of their cognitive and phonological coding skills. Two categories of children with reading difficulties have been widely recognized: the "garden-variety" poor readers who demonstrate cognitive processing problems in many areas and subsequently do not demonstarate IQ reading level discrepancy, and the "dyslexic" poor readers who show specific deficiencies in processes directly related to reading, such as phonological coding and successive processing. The two groups have been suprisingly difficult to diferentiate with measures directly related to reading. We have argued elsewhere that when viewed in the context of PASS (planning, attention, simultaneous, and successive) processes children with reading disability can be categorized into different groups even if all of them have the same difficulty in word-reading and phonemic. Thus, the second questions was: Can planning, attention, successive, and simultaneous processing together with phonological coding be used to identify subgroups of children with early reading problems?

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2. METHOD

Participants

Experimental group consisted of 81 (22 females) Grade 1 students who (1) were identified year earlier by their Kindergarten teachers to be at-risk for experiencing difficulties in early reading (excluding ESL and mentally challenged students) and who (2) scored below 26th percentile both in Word Attack and in Word Identification in January of Grade 1. The mean age for the this group was 76.6 months (SD = 3.8).

Two matched remediation groups were formed by clustering participants on the basis of 15 standardized criterion variables — 10 cognitive processing tasks, 3 phonological processing tasks, and two reading tasks — and then assigning the nearest neighbours into different remediation groups. Subsequent *t* tests on raw scores showed no significant differences between the groups on any of the 15 variables. Moreover, the mean ages and gender distribution were equal. All participants attended public schools in Edmonton, Canada.

Comparison group consisted of 164 Grade 1 students drawn from eight schools in Kingston, Ontario. The mean age for the control group was 76.4 months (SD = 3.5). The mean Word Attack score was 3.18 (SD = 6.77) and the mean Word Identification score was 11.38 (SD = 17.30). from 1 to 3 in both programs.

3. RESULTS

Remediation

Table 1 presents the means and standard deviations (in parenthesis) for the pre- and posttest Word Attack and Word Identification scores for the two remediation groups.

Table 1
Word Attack and Word Identification scores as a Function of Remediation and Testing Time

	Word Attack				Word Identification			
	Pretest		Posttest		Pretest		Posttest	
	Mean	*(SD)*	Mean	*(SD)*	Mean	*(SD)*	Mean	*(SD)*
PREP (n = 29)	.31	(.66)	4.03	(4.30)	4.00	(3.81)	13.24	(8.30)
Meaning (n = 29)	.14	(.35)	1.93	(2.46)	3.52	(3.50)	11.31	(8.82)

Repeated Measures ANOVAs (N=58)

Task	*F*	*p*
Word Attack		
Testing Time	39.96	.000
Remediation by Time	4.90	.031
Word Identification		
Testing Time	103.16	.000
Remediation by Time	.75	.392

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Separate independent samples *t* tests showed that the pretest scores did not differ significantly for either measure whereas the posttest scores for Word Attack were significantly different, $t(56) = 2.29$, $p = .027$.

Repeated measures ANOVA results shown in Table 1 show that the main effect of testing time was significant in both analyses, indicating that over the three month time period the participants had advanced in their basic reading skills.

For Word Attack, Group by Time interaction was also significant. This result indicates that the PREP group improved significantly more than the meaning-based group in their spelling-to-sound conversion skills. Similar differences were not evident for Word Identification. Instead, both groups seemed to benefit from remediation to about equal extent.

Subgroups of Children with Reading Difficulties

The second objective of this study was to examine if planning, attention, successive, and simultaneous processing tasks together with phonological coding tasks can be used to identify subgroups of children with early reading problems.

Cluster analysis (Ward's method, squared euclidean distance) was computed with the experimental group (N=61) using standardized cognitive and phonological variables in order to identify possible subgroups of children with reading problems.

Clustering produced a clear three cluster solution. Three cluster solution had 24 participants in the first cluster, 9 participants in the second cluster, and 28 participants in the third cluster. MANOVA with the three clusters as factors and 11 cognitive and phonological tasks (raw scores) as independent variables indicated that the main effect of Cluster was highly significant, $\Lambda = .055$, $F(22, 96) = 14.25$, $p < .001$. This suggests that the three clusters indeed represented groups of participants who were performing differently on cognitive and phonological tasks. Moreover, subsequent univariate F tests indicated that the main effect of Cluster was significant for all other tasks but Word Series.

Examination of means and standard deviations on the cognitive, phonological, and reading tasks for the three clusters as well for the comparison group indicated that the three clusters exhibited clearly different patterns of strengths and weaknesses in terms of their performance on cognitive and phonological tasks. While Cluster 1 performed at a lower level than the comparison group on all tasks, the same was not true for the other two clusters. To examine this point further, two different analyses were conducted. First, post hoc pairwise comparisons were calculated comparing each of the three clusters with the comparison group. Second, effect sizes for the mean differences between the three clusters and the comparison group were calculated.

Table 2 summarizes the results from the post hoc pairwise comparisons (joint univariate Bonferroni test with the significance level of .05) between the three clusters and the comparison group.

Pairwise comparisons indicated that the differences between the comparison group and Cluster 1 were significant on all of the cognitive and phonological tasks. Cluster 3, in contrast, was significantly different from the comparison group on all successive and phonological tasks but not on planning, attention, and simultaneous tasks. Finally, Cluster 2 was significantly different from the comparison group only on the Planned Connections and the Word Series tasks, and the difference was marginally significant for the Speech Rate task. We should note that several participants in the at-risk group experienced problems with the Planned Connections task that requires knowledge of numbers up ten. Thus, rather than reflecting real differences in planning skills, significant differences in this task may reflect differences in number knowledge.

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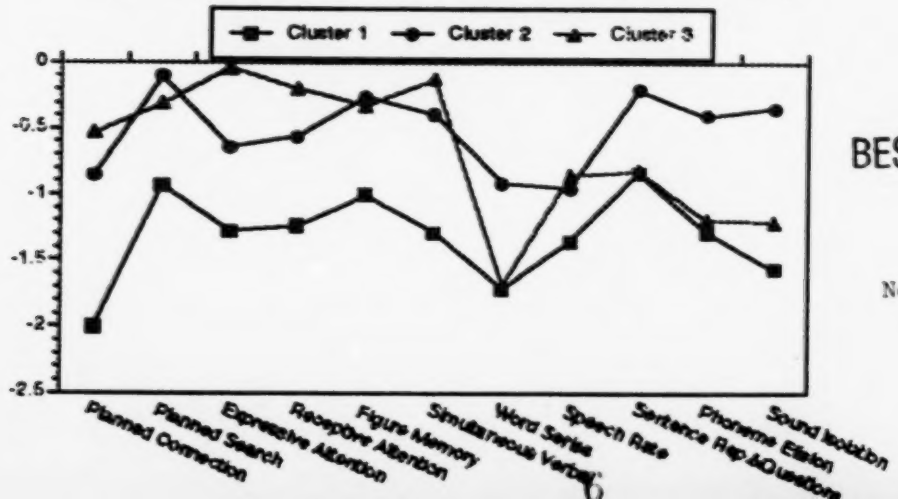
Table 2--Summary of the Pairwise Comparisons between the Three Clusters & the Comparison Group

Variables	Comparison group versus Garden-Variety	No Deficit?	Dyslexics?
Planned Connections	+	+	ns
Planned Search	+	ns	ns
Expressive Attention	+	ns	ns
Receptive Attention	+	ns	ns
Figure Memory	+	ns	ns
Simultaneous Verbal	+	ns	ns
Word Series	+	+	+
Speech Rate	+	ns	+
Sentence Repetion and Questions	+	ns	+
Phoneme Elision	+	ns	+
Sound Isolation	+	ns	+

Note. Joint univariate Bonferroni test with .05 significance level;
+ indicates significant difference; ns indicates that the difference was not significant

Figure 1 displays the effect sizes for the mean differences in cognitive tasks for the three clusters and the comparison group. X-axis represent the comparison group performance and Y-axis shows the standardized distance between each of the clusters and the comparison group. In terms of interpreting effect sizes, Cohen (1969) suggests that effect sizes smaller than .5 should be regarded as small, .5 to .8 as medium, and over .8 as large. Conceptually effect sizes can be interpreted as an approximation of group differences in standard units. Thus, effect size of .5 indicates that the difference between the groups was about half a standard deviation unit.

Figure 1
Effect sizes for the mean differences in cognitive and phonological tasks for the three clusters and the comparison group (X-axis).



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Note. X-axis represent the the comparison group performance and the Y-axis shows the standardized distance between each of the clusters & the comparison group.

Conclusions

Two questions were addressed in this study: (1) How effective is a cognitive training program in remediating early reading difficulties, and (2) Are children displaying early reading difficulties a homogeneous group in terms of their cognitive and phonological skills?

The results of this study are very encouraging for the proponents of cognitive remediation. Rather than directly teaching phonological coding skills, clear improvement in word decoding skills were achieved by training cognitive processes underlying the phonological coding skills. The efficacy of the PREP program in ameliorating reading difficulties was proven again, as would be expected on the basis of previous intervention studies. This time, however, the evidence is stronger than before since the comparison group was not only an "attention" control group, but a matched group of children who received a meaningful intervention. That the meaning-based intervention was relevant for reading skills is evident in improved word reading skills for both groups. That PREP was more efficient is, in turn, evident in significantly higher gains in word decoding skills.

An important feature of this study was that the target group consisted of Grade 1 students. At this level, the most important function of a remediation program is to prevent further reading related problems from materializing. While Grade 1 and even Grade 2 students can function relatively well in other academic subjects even with deficient reading skills, by Grade 3 reading penetrates all other subject areas. As a consequence, secondary problems become more prevalent. To avoid this, we need to both identify the at-risk children early as well as have remediation procedures that do not depend on existing or expected reading proficiency. This is where cognitive remediation has its greatest potential.

In terms of the second question, our results suggest that children with early reading difficulties are far from a homogeneous group. Cluster 1 seemed to capture a group of children with reading difficulties whose performance level was poor also on most cognitive and phonological tasks. In the existing literature, this group of children is often referred to as the "garden-variety" poor readers. Children in Cluster 2, in contrast, displayed a high overall performance level. It is interesting to notice that Cluster 2 performed near the comparison group level on both phonological coding tasks. Why these children experienced reading difficulties is not explained by our tasks. Some possible explanations not controlled for in this study could be motivation, poor literacy environment at home, or "visual deficit". The last alternative is, however, unlikely since they performed on a high level on several tasks requiring processing of complex visually presented information.

Cluster 3, in contrast, represents the group of children that is generally referred to as "true dyslexics". They performed successfully on all planning, attention, and simultaneous processing tasks but not so on successive processing and phonological coding tasks. The interesting point here is that successive processing tasks are not "directly" related to reading and yet this group experienced problems with them. This supports the claim that successive processing tasks are indirectly related to reading, either as prerequisite for phonological coding, or as explaining the reading variance that phonological tasks cannot explain. Longitudinal studies currently under way will address this question in more detail.

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